

- (A) pertactins of *Bordetella bronchiseptica*;
- (B) pertactins of *Bordetella parapertussis*; and
- (C) pertactins of *Bordetella pertussis*,

in amounts sufficient to induce a humoral or cellular immune response against at least one of:

- (D) *Bordetella bronchiseptica*;
- (E) *Bordetella parapertussis*; and
- (F) *Bordetella pertussis*;

in an animal to which the immunogenic composition is administered.

B¹ 57. (NEW) The immunogenic composition of claim 56, wherein the pertactins of *Bordetella* species, fragments and variants thereof, comprise at least one of Region I, and Region II.

58. (NEW) The immunogenic composition of claim 56, further comprising at least one of Region I and Region II of the pertactins of at least one of:

- (A) *Bordetella bronchiseptica*;
- (B) *Bordetella parapertussis*; and
- (C) *Bordetella pertussis*.

Sub C5 59. (NEW) The immunogenic composition of claim 56, wherein the pertactins of *Bordetella* species, fragments and variants thereof, comprise at least one of:

(A) 1, 2, or 3 repeating GGXXP amino acid sequences of Region I; and

(B) 6, 7, 8, or 9 repeating PQP amino acid sequences of Region II.

60. (NEW) The immunogenic composition of claim 56, further comprising at least

one of:

(A) 1, 2, or 3 repeating GGXXP amino acid sequences of Region I; and

(B) 6, 7, 8, or 9 repeating PQP amino acid sequences of Region II

of the pertactins of at least one of:

(C) *Bordetella bronchiseptica*;

(D) *Bordetella parapertussis*; and

(E) *Bordetella pertussis*.

61. (NEW) The immunogenic composition of claim 58, further comprising at least

one of:

(A) 1, 2, or 3 repeating GGXXP amino acid sequences of Region I; and

(B) 6, 7, 8, or 9 repeating PQP amino acid sequences of Region II

of the pertactins of at least one of:

(C) *Bordetella bronchiseptica*;

(D) *Bordetella parapertussis*; and

(E) *Bordetella pertussis*.

62. (NEW) A polypeptide comprising a sequence or a fragment of the sequence

of: SEQ ID NO: 7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO: 14, SEQ ID NO: 15, SEQ

ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, or SEQ ID NO: 22, wherein the sequence or fragment of the sequence includes the Region I or Region II repeat sequences.

63. (NEW) A polypeptide consisting of the amino acids in SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 14, SEQ ID NO: 15, SEQ ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, or SEQ ID NO: 22.

64. (NEW) A polynucleotide encoding a polypeptide as claimed in claim 62. ✓

65. (NEW) A polynucleotide encoding a polypeptide as claimed in claim 63. ✓

66. (NEW) A purified DNA or RNA sequence that hybridizes under moderate or high stringency conditions to the polynucleotide of claim 64 or at least to 15 nucleotides thereof. ✓

67. (NEW) Purified antibodies that bind to a polypeptide of claim 62. ✓

68. (NEW) Purified antibodies according to claim 67, wherein the antibodies are monoclonal antibodies. ✓

69. (NEW) Purified antibodies according to claim 67, wherein the antibodies are polyclonal antibodies. ✓

70. (NEW) An immunological complex comprising a polypeptide of claim 62 and an antibody that specifically recognizes said polypeptide. ✓

71. (NEW) A method for detecting infection by Bordetella, wherein the method comprises providing a composition comprising a biological material suspected of being

infected with Bordetella, and assaying for the presence of a polypeptide of claim 62. ✓

72. (NEW) The method as claimed in claim 71, wherein the polypeptide is assayed by electrophoresis or by immunoassay with antibodies that are immunologically reactive with the polypeptide. ✓

73. (NEW) An *in vitro* diagnostic method for the detection of the presence or absence of antibodies, which bind to an antigen comprising a polypeptide of claim 62, wherein the method comprises contacting the antigen with a biological fluid for a time and under conditions sufficient for the antigen and antibodies in the biological fluid to form an antigen-antibody complex, and detecting the formation of the complex. ✓

74. (NEW) The method as claimed in claim 73, which further comprises measuring the formation of the antigen-antibody complex. ✓

75. (NEW) The method as claimed in claim 73, wherein the formation of antigen-antibody complex is detected by immunoassay based on at least one of Western blot technique, ELISA, indirect immunofluorescence assay, and immunoprecipitation assay. ✓

76. (NEW) A diagnostic kit for the detection of the presence or absence of antibodies, which bind a polypeptide of claim 62 or mixtures thereof, wherein the kit comprises an antigen comprising a polypeptide of claim 62 or mixtures of said polypeptides, and means for detecting the formation of immune complex between the antigen and antibodies, wherein the means are present in an amount sufficient to perform said detection. ✓

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77. (NEW) An immunogenic composition comprising at least one polypeptide of claim 62 in an amount sufficient to induce an immunogenic or protective response *in vivo*, and a pharmaceutically acceptable carrier therefor.

78. (NEW) The immunogenic composition as claimed in claim 56, wherein said composition further comprises a neutralizing amount of at least one polypeptide of SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 14, SEQ ID NO: 15, SEQ ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, or SEQ ID NO: 22.

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79. (NEW) The immunogenic composition of claim 57, wherein the composition comprises a neutralizing amount of at least one polypeptide of SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 14, SEQ ID NO: 15, SEQ ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, or SEQ ID NO: 22.

80. (NEW) The immunogenic composition of claim 59, wherein the composition comprising a neutralizing amount of at least one polypeptide of SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 14, SEQ ID NO: 15, SEQ ID NO: 15, SEQ ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, or SEQ ID NO: 22.

81. (NEW) An immunogenic composition comprising a polynucleotide according to claim 64.

82. (NEW) A vaccine comprising an immunogenic composition according to

✓
claim 56 along with a pharmaceutically acceptable vehicle.

83. (NEW) A method for detecting the presence or absence of *Bordetella* comprising:

- (1) contacting a sample suspected of containing genetic material of *Bordetella* with at least one nucleotide probe, and
- (2) detecting hybridization between the nucleotide probe and the genetic material in the sample,

wherein said nucleotide probe is complementary to a polynucleotide sequence as claimed in claim 64. ✓

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84. (NEW) A vaccination kit comprising at least an immunogenic composition according to claim 56, ✓ and means for administering the composition to an animal.

85. (NEW) An immunogenic composition consisting essentially of:

- (A) a polypeptide comprising at least one of Region I and Region II of a pertactin of *Bordetella pertussis*;
- (B) a polypeptide comprising at least one of Region I and Region II of a pertactin of *Bordetella parapertussis*;
- (C) a polypeptide comprising at least one of Region I and Region II of a pertactin of *Bordetella bronchiseptica* strain 9.73 and a polypeptide comprising at least one of Region I and Region II of a pertactin of *Bordetella bronchiseptica* of strain SEI.

86. (NEW) An immunogenic composition consisting essentially of:

(A) a pertactin of *Bordetella bronchiseptica*;

(B) FHA of *Bordetella bronchiseptica*; and

(C) a pertactin of *Bordetella parapertussis*.

87. (NEW) The immunogenic composition as claimed in claim 86, wherein the pertactin of *Bordetella bronchiseptica* is from strain 9.73.

88. (NEW) The immunogenic composition as claimed in claim 86, where the FHA of *Bordetella bronchiseptica* is from strain 9.73.

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89. (NEW) An immunogenic composition as claimed in claim 56, wherein the composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

90. (NEW) An immunogenic composition as claimed in claim 59, wherein the composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

91. (NEW) An immunogenic composition as claimed in claim 57, wherein the composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

92. (NEW) An immunogenic composition as claimed in claim 59, wherein the

composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

93. (NEW) An immunogenic composition as claimed in claim 79, wherein the composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

94. (NEW) An immunogenic composition as claimed in claim 80, wherein the composition further comprises at least one of an adhesin of *Bordetella* and a toxin of *Bordetella*; where in the adhesin is selected from at least one of FHA, AGG2, AGG3 and the toxin is selected from at least one of PTX, DNT, TCT, and Ac-Hly.

95. A method of treating *Bordetella* infections, comprising administering the antibodies of claim 67.

96. (NEW) A microarray comprising microbeads, wherein said microbeads each bears multiple copies of a polynucleotide according to claim 64 or a fragment thereof, and wherein the polynucleotide or fragment thereof is different from one microbead to another.

97. (NEW) A DNA chip, wherein the chip comprises at least one polynucleotide according to claim 66 or fragment thereof.

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